CAPT. ZILE SINGH SCHOOL

Fully Centralized AC School for Boys & Girls

OLYMPIAD EXAM : CLASS 11ᵀᴴ

Time Duration : 1 Hours **Max. Marks :** 50

I N S T R U C T I O N S

1. Write your 12 digit iOS roll number and your name on top of the question paper in the given space.
2. Filling up improper roll number may lead to unavailability of 'Result'.
3. This question paper consist of 40 questions. Each question carries equal marking of 2.5 marks each.
4. This paper is divided into 4 sections. Section A and B are compulsory for all the candidates. However section C and D are to be answered by the candidates as per their choice of subject, i.e. either Mathematics or Biology.
5. Mark your answer (A, B, C, D or E) on the Answer Sheet with HB Pencil or Black/Blue Ball point Pen.
6. This question paper contains 6 pages.
7. Do not start attempting the test paper until you are asked to do so.

Note: Return this question paper along with answer sheet

SECTION A: Physics

1. Two stones are thrown up simultaneously with initial speeds of u_1 and u_2 ($u_2 > u_1$). They hit the ground after 6 s and 10 s respectively. If it is assumed that the stones do not rebound after hitting the ground, then which of the following graph correctly represents the time variation of $\Delta x = (x_2 - x_1)$, the relative position of the second stone with respect to the first, upto t = 10 s?

(A)

(B) `

(C)

(D)

(E) None of these
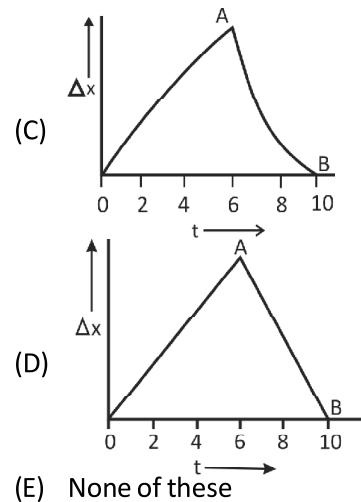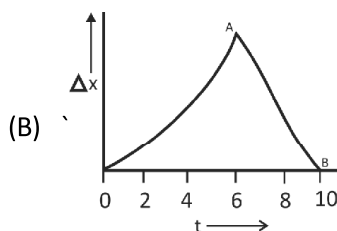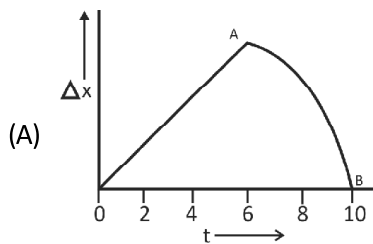
2. When a plane wave travels in a medium, the displacement y of a particle located at x at time t is given by
   $$y = a \sin (bt - cx)$$
   where a, b, and c are constants.
   (A) The unit of a is the same as that of y.
   (B) The SI unit of b is Hz.
   (C) The dimensional formula of c is $[M^0 L^{-1} T^0]$.
   (D) The dimensions of $\dfrac{b}{c}$ are the same as those of velocity.
   (E) All of these

3. A plumb line is hanging from the ceiling of a train. If the train moves along a horizontal track with a uniform acceleration a, the plumb line gets inclined to the vertical at an angle

(A) $\tan^{-1}\left(\dfrac{a}{g}\right)$ (B) $\tan^{-1}\left(\dfrac{g}{a}\right)$

(C) $\sin^{-1}\left(\dfrac{a}{g}\right)$ (D) $\cos^{-1}\left(\dfrac{g}{a}\right)$

(E) None of these

4. The over-bridge of a river is in the form of a circular arc of radius of curvature 10 m. If g = 10 ms⁻², then what is the highest speed at which a motorcyclist can cross the bridge without leaving the ground?

(A) $5\ ms^{-1}$ (B) $10\sqrt{2}\ ms^{-1}$

(C) $10\ ms^{-1}$ (D) $5\sqrt{2}\ ms^{-1}$

(E) None of these

5. Two identical balls marked 2 and 3, in contact with each other and at rest on a horizontal frictionless table, are hit head-on by another identical ball marked 1 moving initially with a speed v as shown below. What is observed, if the collision is elastic ?
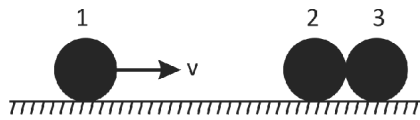
(A) Ball 1 comes to rest and balls 2 and 3 roll out with speed $\dfrac{v}{2}$ each.

(B) Balls 1 and 2 come to rest and ball 3 rolls out with speed v.

(C) Balls 1, 2 and 3 roll out with speed $\dfrac{v}{3}$ each.

(D) Balls 1, 2 and 3 come to rest.

(E) None of these

6. A cubical block of side L rests on a rough horizontal surface with coefficient of friction μ. A horizontal force F is applied on the block as shown in the figure given below. If the coefficient of friction is sufficiently high so that the block does not slide before toppling, then the minimum force required to topple the block is

(A) infinitesimal (B) $\dfrac{mg}{4}$

(C) $\dfrac{mg}{2}$ (D) $mg(1-\mu)$

(E) None of these

7. If a geo-stationary satellite orbits around the earth in a circular orbit of radius 36000 km, then the time period of a spy satellite orbiting a few hundred kilometres above the earth's surface (R_{Earth} = 6400 km) will be

(A) 0.5 h (B) 1 h

(C) 1.8 h (D) 4 h

(E) None of these

8. A block of mass M is suspended from a wire of mass m, cross-sectional area A and length L. If all the energy stored in the wire is converted into heat, the rise in the temperature of the wire is (Y = Young's modulus and s = specific heat capacity of the material of the wire)

(A) $\dfrac{(Mg)^2 L}{2YAms}$ (B) $\dfrac{MgLms}{2YA}$

(C) $\dfrac{2YAL}{(Mg)^2 ms}$ (D) $\dfrac{MgmL}{2AYs}$

(E) None of these

9. A long metal rod of length ℓ and relative density σ is held vertically with its lower end just touching the surface of water. The speed of the rod when it just sinks in water is given by

(A) $\sqrt{2g\ell}$ (B) $\sqrt{2g\ell\sigma}$

(C) $\sqrt{2g\ell\left(1-\dfrac{1}{2\sigma}\right)}$ (D) $\sqrt{2g\ell(2\sigma-1)}$

(E) None of these

10. Equal masses of two substances of densities ρ_1 and ρ_2 are mixed together. The density of the mixture would be

(A) $\dfrac{1}{2}(\rho_1+\rho_2)$ (B) $\sqrt{\rho_1\rho_2}$

(C) $\dfrac{\rho_1\rho_2}{\rho_1+\rho_2}$ (D) $\dfrac{2\rho_1\rho_2}{\rho_1+\rho_2}$

(E) None of these

11. A man of mass m is standing on the floor of a lift. Which of the following is not correct?

(A) When the lift is stationary, his weight is mg.

(B) When the lift is moving up with a uniform speed of 2 ms⁻¹, his weight is 5mg.

(C) When the lift is moving up with a uniform acceleration a (< g), his weight is m(g + a).

(D) When the lift is moving down with a uniform acceleration a (< g), his weight is m(g − a).
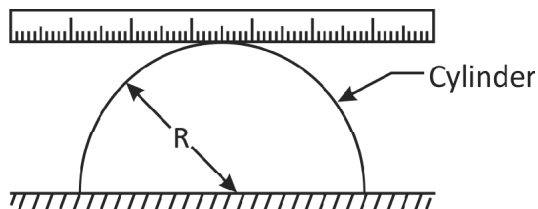
(E) None of these

12. Two identical cylindrical vessels, with their bases at the same level, each contain a liquid of density ρ. The height of the liquid in one vessel is h_1 and that in the other is h_2. The area of either base is A. What is the work done by gravity in equalizing the levels when the vessels are interconnected ?

(A) $A\rho g (h_1 - h_2)^2$

(B) $A\rho g (h_1 + h_2)^2$

(C) $A\rho g \left(\dfrac{h_1 - h_2}{2}\right)^2$

(D) $A\rho g \left(\dfrac{h_1 + h_2}{2}\right)^2$

(E) None of these

13. A string of length L and of negligible mass hangs from a support O. The other end of the string carries a mass m which is moved in a horizontal circle of radius R to form a conical pendulum. If the string makes an angle θ = 60° with the vertical, then which one of the following statements are correct?

(A) The speed of the body along the circle is $v = \sqrt{1.73Rg}$.

(B) The tension in the string is 2mg.

(C) The horizontal component of the angular momentum of the body about the point O is

$\dfrac{\sqrt{3}}{2}mL\sqrt{\dfrac{Lg}{2}}$.

(D) The magnitude of the torque acting on the body about point O is $\dfrac{\sqrt{3}}{2}mgL$.

(E) All of these

14. A uniform metre scale of length 1 m is balanced on a fixed semi-circular cylinder of radius 30 cm as shown in the figure given below. One end of the scale is slightly depressed and released. The time period (in seconds) of the resulting simple harmonic motion is (Take g = 10 ms^{-2})

(A) π

(B) $\dfrac{\pi}{2}$
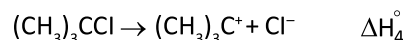
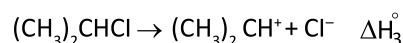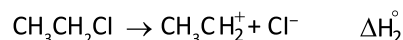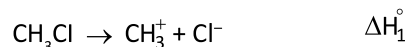(C) $\dfrac{\pi}{3}$

(D) $\dfrac{\pi}{4}$

(E) None of these

15. The figure given below shows a cyclic process ABCA in the V-T diagram. Which of the diagrams given in options shows the same process on a P-V diagram?
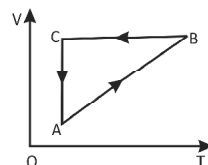
(A) (B) (C) (D)

(E) None of these

SECTION B: Chemistry

16. Consider the following reactions:

$CH_3Cl \rightarrow CH_3^+ + Cl^-$ $\qquad \Delta H_1^\circ$

$CH_3CH_2Cl \rightarrow CH_3CH_2^+ + Cl^-$ $\qquad \Delta H_2^\circ$

$(CH_3)_2CHCl \rightarrow (CH_3)_2CH^+ + Cl^-$ $\quad \Delta H_3^\circ$

$(CH_3)_3CCl \rightarrow (CH_3)_3C^+ + Cl^-$ $\qquad \Delta H_4^\circ$

The correct order of their enthalpies of ionization is

(A) $\Delta H_1^\circ > \Delta H_2^\circ > \Delta H_3^\circ > \Delta H_4^\circ$

(B) $\Delta H_1^\circ < \Delta H_2^\circ < \Delta H_3^\circ < \Delta H_4^\circ$

(C) $\Delta H_1^\circ > \Delta H_2^\circ > \Delta H_3^\circ < \Delta H_4^\circ$

(D) $\Delta H_1^\circ > \Delta H_2^\circ < \Delta H_3^\circ < \Delta H_4^\circ$

(E) None of these

17. Which of the following graph shows the variation of per cent ionic character and electronegativity difference for H – X (where X is halogen)?

(A) (B) (C) (D)

(E) None of these

18. For a diatomic gas, at low temperature
- (A) molar heat capacity at constant volume, $C_{V,m}$ < 3.5 R
- (B) molar heat capacity at constant pressure, $C_{p,m}$ = 4.5 R
- (C) the ratio of $C_{p,m}$ and $C_{V,m}$ is 7/9
- (D) the difference between $C_{p,m}$ and $C_{V,m}$ is 2R
- (E) None of these

19. What wavelength of the radiation will be required to cause the ionization of Li^{2+} in the ground state?
Given: $4\pi\varepsilon_0 = 1.112 \times 10^{-10}\,C^2N^{-1}M^{-2}$
- (A) $9.000 \times 10^{-11}\,m$
- (B) $1.090 \times 10^9\,m$
- (C) $1.019 \times 10^{-8}\,m$
- (D) $1.090 \times 10^{-7}\,m$
- (E) All of these

20. The ionic radii of Li^+, Be^{2+} and B^{3+} follow the order:
- (A) $Li^+ < Be^{2+} < B^{3+}$
- (B) $B^{3+} < Be^{2+} < Li^+$
- (C) $Li^+ < B^{3+} < Be^{2+}$
- (D) $B^{3+} < Li^+ < Be^{2+}$
- (E) None of these

21. Which of the following statements is correct?
- (A) The basic strength of hydroxides of alkaline earth metal increases down the group.
- (B) The solubilities of sulphates and carbonates of alkaline earth metal decrease down the group.
- (C) The sulphates of alkaline earth metal are stable to heat.
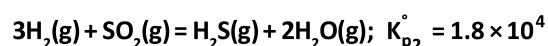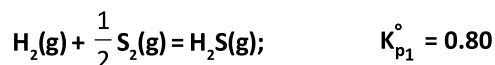- (D) The carbonates of alkaline earth metal decompose on heating.
- (E) All of these

22. Which of the following species does not involve tetrahedral structure ?
- (A) SO_4^{2-}
- (B) SF_4
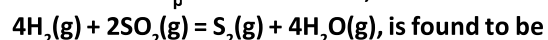- (C) SeO_4^{2-}
- (D) SO_2Cl_2
- (E) None of these

23. The bond enthalpies of H–H and Cl–Cl are 430 and 242 kJ mol^{-1}. If $\Delta_f H(HCl)$ is – 91 kJ mol^{-1}, then the bond enthalpy of HCl would be
- (A) – 214 kJ mol^{-1}
- (B) – 427 kJ mol^{-1}
- (C) 214 kJ mol^{-1}
- (D) 427 kJ mol^{-1}
- (E) None of these

24. Look at the information given below:
$$H_2(g) + \frac{1}{2}S_2(g) = H_2S(g); \quad K_{p_1}^{\circ} = 0.80$$
$$3H_2(g) + SO_2(g) = H_2S(g) + 2H_2O(g); \quad K_{p_2}^{\circ} = 1.8 \times 10^4$$
The value of K_p° for the reaction,
$$4H_2(g) + 2SO_2(g) = S_2(g) + 4H_2O(g),\text{ is found to be}$$
- (A) 2.44×10^{-5}
- (B) 4.25×10^4
- (C) 5.07×10^8
- (D) 7.26×10^6
- (E) None of these

25. If for the reaction, $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$, $\Delta H = -180\,kJ\,mol^{-1}$, then which of the following facts does not hold good?
- (A) The pressure changes at constant temperature do not affect the equilibrium constant.
- (B) The volume changes at constant temperature do not affect the equilibrium constant.
- (C) The dissociation of NO is favoured more at high temperature.
- (D) The dissociation of NO is favoured less at high temperature.
- (E) None of these

26. A 1.0 g sample of Fe_2O_3 solid of 55.2% purity is dissolved in acid and reduced by heating the solution with zinc dust. The resultant solution is cooled and made up to 100.0 ml. An aliquot of 25.0 ml of this solution requires 17.0 ml of 0.0167 M solution of an oxidant for titration. Calculate the number of electrons taken up by the oxidant in the reaction of the above titration.
- (A) 6
- (B) 10
- (C) 18
- (D) 24
- (E) None of these

27. A mixture of $NH_3(g)$ and $N_2H_4(g)$ is placed in a sealed container at 300 K. The total pressure is 0.5 atm. The container is heated to 1200 K, at which time both substances decompose completely according to the equations
$$2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$$
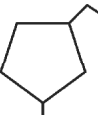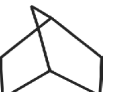and $N_2H_4(g) \rightarrow N_2(g) + 2H_2(g)$
After decomposition is complete, the total pressure at 1200 K is found to be 4.5 atm. Find the amount per cent of $N_2H_4(g)$ in the original mixture.
- (A) 12.38 %
- (B) 19.95 %
- (C) 25.00 %
- (D) 38.00 %
- (E) None of these
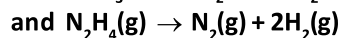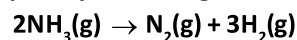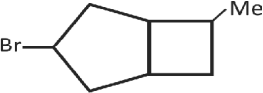
28. 4 kg of ice at – 20°C is mixed with 10 kg of water at 20 °C in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. Given : Specific heat capacities of water and ice are 4.184 kJ K^{-1}kg^{-1} and 2.092 kJK^{-1}kg^{-1}, respectively. Molar enthalpy of fusion of ice is 334.7 kJ kg^{-1}
- (A) 8 kg
- (B) 10 kg
- (C) 12 kg
- (D) 14 kg
- (E) None of these

29. Which of the following statements is correct ?

(A) is 1-methyl-3-ethylcyclopentane.

(B) is 1-cyclobutyl-3-methylcyclopentane.

(C) is bicyclo[2.2.2] heptane.

(D) is 2-methyl-6-bromobicyclo[2.3.0]heptane.

(E) None of these

30. Silver nitrate is added to each of 7-bromo-1,3,5-cycloheptatriene (P) and 5-bromo-1,3-cyclopentadiene (Q). It is observed that

(A) both P and Q give AgBr precipitation

(B) both P and Q do not give AgBr precipitation

(C) P gives AgBr precipitation while Q does not give AgBr precipitation

(D) P does not give AgBr precipitation while Q forms AgBr precipitation.

(E) None of these

SECTION C: Mathematics

31. If the 6th term in the expansion of $\left(\dfrac{1}{x^{8/3}} + x^2 \log_{10} x\right)^8$ is 5600, then value of x is

(A) 2   (B) $\sqrt{5}$

(C) $\sqrt{10}$ (D) 10

(E) None of these

32. $\underset{x\to 0}{\text{Lt}}\left[\tan\left(\dfrac{\pi}{4}+x\right)\right]^{1/x}$ is equal to

(A) e (B) e^2

(C) e^3 (D) e^{-1}

(E) None of these

33. The sum of all three digit numbers (no digit being zero) having the property that all digits are perfect squares, is

(A) 3108

(B) 6216

(C) 13986

(D) 24296

(E) None of these

34. The statement $p \to (q \to p)$ is equivalent to

(A) $p \to (p \to q)$ (B) $p \to (p \vee q)$

(C) $p \to (p \wedge q)$ (D) $p \to (p \leftrightarrow q)$

(E) None of these

35. In a model, it is shown that an arc of a bridge is semi-elliptical with major axis horizontal. If the length of the base is 9m and the highest part of the bridge is 3m from the horizontal; then the best approximation of the height of the arch at 2m from the centre of the base is

(A) 11/4 m   (B) 8/3 m

(C) 7/2 m   (D) 2 m

(E) None of these

36. If $\theta \in (\pi/4, \pi/2)$, then which of the following statements is true?

(A) $(\cos\theta)^{\cos\theta} < (\sin\theta)^{\cos\theta} < (\cos\theta)^{\sin\theta}$

(B) $(\cos\theta)^{\sin\theta} < (\cos\theta)^{\cos\theta} < (\sin\theta)^{\cos\theta}$

(C) $(\sin\theta)^{\cos\theta} < (\cos\theta)^{\cos\theta} < (\cos\theta)^{\sin\theta}$

(D) $(\cos\theta)^{\cos\theta} < (\cos\theta)^{\sin\theta} < (\sin\theta)^{\cos\theta}$

(E) None of these

37. α, β are roots of the equation $\lambda(x^2 - x) + x + 5 = 0$. If λ_1 and λ_2 are the two values of λ for which the roots α, β are connected by the relation $\dfrac{\alpha}{\beta} + \dfrac{\beta}{\alpha} = 4$, then the value of $\dfrac{\lambda_1}{\lambda_2} + \dfrac{\lambda_2}{\lambda_1}$ is

(A) 1050   (B) 1254

(C) 2180   (D) 1022

(E) None of these

38. Coefficient of the term independent of x in the expansion of $\left(\dfrac{x+1}{x^{2/3} - x^{1/3} + 1} - \dfrac{x-1}{x - x^{1/2}}\right)^{10}$ is

(A) 210   (B) 105

(C) 70   (D) 35

(E) None of these

39. If $A = \{\theta : 2\cos^2\theta + \sin\theta \le 2\}$ and $B = \left\{\theta : \dfrac{\pi}{2} \le \theta \le \dfrac{3\pi}{2}\right\}$, then $A \cap B$ is equal to

(A) $\left\{\theta : \dfrac{\pi}{2} \le \theta \le \dfrac{5\pi}{6}\right\}$

(B) $\left\{\theta : \pi \le \theta \le \dfrac{3\pi}{2}\right\}$

(C) $\left\{\theta : \dfrac{\pi}{2} \le \theta \le \dfrac{5\pi}{6} \text{ or } \pi \le \theta \le \dfrac{3\pi}{2}\right\}$

(D) $\left\{\theta : \dfrac{\pi}{6} \le \theta \le \dfrac{\pi}{4} \text{ or } \pi \le \theta \le \dfrac{5\pi}{6}\right\}$

(E) None of these

40. If the roots of $z^2 + az + b = 0$ are purely imaginary, then

(A) $\left(b - \overline{b}\right)^2 + \left(a + \overline{a}\right)\left(a\overline{b} + \overline{a}b\right) = 0$

(B) $\left(b - \overline{b}\right)^2 + \left(a - \overline{a}\right)^2 = 0$

(C) $\left(b + \overline{b}\right)^2 - \left(a - \overline{a}\right)^2 = 0$

(D) $\left(b - \overline{b}\right)^2 - \left(a + \overline{a}\right)\left(\overline{a} - \overline{b}\right)^2 = 0$

(E) None of these

SECTION D: Biology

31. Which one of the following is a derivative of steroid?
(A) Ester of fatty acid
(B) Vitamin A
(C) Thyroid hormone
(D) Cholesterol
(E) None of these

32. Which one of the following statements about viruses is correct?
(A) Nucleic acid of viruses is known as capsid.
(B) Viruses are obligate parasites.
(C) Viruses possess their own metabolic system.
(D) All viruses contain both DNA and RNA.
(E) None of these

33. A cytologist examines a number of slides of onion root-tip cells in various stages of mitosis. Of 1000 cells counted, 700 were in prophase, 100 in metaphase, 34 in anaphase and 166 in telophase. From these observations, it can be concluded that :
(A) the duration of each stage is different, prophase being shortest and anaphase longest.
(B) most cells do not proceed beyond prophase.
(C) prophase is longest, followed by telophase and metaphase and anaphase being shortest.
(D) All of these
(E) None of these

34. The second meiotic division leads to
(A) separation of sex chromosomes
(B) separation of chromatids and centromeres
(C) fresh DNA synthesis
(D) separation of homologous chromosomes
(E) None of these

35. Which of the following statements are not correct about the muscular system?
(A) Flexors decrease the angle of a joint.
(B) Adductors move a limb away from the midline.
(C) Tendons attach muscle to bone.
(D) Bones contact other bones at joints.
(E) None of these

36. The quiescent centre in root meristem serves as a :
(A) region for absorption of water.
(B) reserve for replenishment of damaged cells of the meristem.
(C) reservoir of growth hormones.
(D) site for storage of food which is utilized during maturation.
(E) None of these

37. Syngenesious condition is
(A) when filaments of stamen are fused and the anthers are free
(B) when carpels are fused
(C) when stamens and carpels are fused
(D) when filaments are free but the anthers are fused
(E) None of these

38. When the normal heart of a frog is injected with physiological concentration of adrenaline it shows
(A) first increased then normal rate
(B) decreased rate
(C) sustained increased rate
(D) systolic arrest
(E) None of these

39. When the dark period of short day plants is interrupted by a brief exposure of light, then the plant
(A) give more flowers.
(B) flower immediately.
(C) will not flower at all.
(D) turn into a long day plant.
(E) None of these

40. DCMU is a herbicide which kills the plant by
(A) inhibiting carbon dioxide fixation as it is a strong inhibitor of pigment system-II
(B) inhibiting photolysis of water as it is a strong inhibitor of pigment system-I
(C) checking respiration
(D) destroying chloroplast
(E) None of these